REPORT NO. 83-2-12
ALEXANDRIA FIELD OFFICE

3400
DECEMBER 1982

FINAL REPORT

PILOT TEST FOR CONTROLLING CONEWORMS AND SEEDBUGS BY AERIAL APPLICATION OF PYDRIN® AND GUTHION® AT THE BEAUREGARD STATE SEED ORCHARD, DERIDDER, LOUISIANA[1/]

by

Julie C. Weatherby and Neil A. Overgaard[2/]

ABSTRACT

A two year pilot test was conducted during 1980 and 1981 at the Beauregard State Seed Orchard, Louisiana Office of Forestry, to demonstrate the efficacy of aerial application of Pydrin and Guthion for coneworm and seedbug control. The 2 year flower-cone survival rates for the check, Guthion, and Pydrin blocks averaged 30%, 67%, and 66%, respectively. The seed efficiency (sound seed/seed potential) in the check, Guthion, and Pydrin blocks averaged 22%, 48%, and 52% in 1980, and 20%, 64%, and 60% in 1981, respectively. The Pydrin applications compared favorably with the Guthion applications and both treatments improved cone and seed yields significantly compared to the check treatment.

INTRODUCTION

Insects are major factors limiting both cone and seed crops in southern pine seed orchards. Much of the identifiable cone and seed damage is caused by coneworm and seedbug feeding. Historically, seed orchard pest management strategies have involved repeated applications with ground equipment of Guthion or a single application of Furadan® 10G. Because of its relatively high toxicity (acute oral LD_{50}(RAT)=5-20 mg/kg) to both mammals and other non-target organisms, Guthion has caused concern among orchard managers. Furadan has provided erratic protection because translocation is dependent upon adequate soil moisture. Orchard managers have sought other alternatives to alleviate these problems.

1/ Mention of commercial products in this paper does not constitute endorsement by the USDA to the exclusion of other products that may be suitable.

2/ Entomologists, USDA Forest Service, Southern Region, State and Private Forestry, FPM, Pineville, LA 71360.

This pilot test was designed to: 1) obtain efficacy data for aerial application of Pydrin and Guthion, 2) develop operational aerial application data, and, 3) obtain data, to support registration, on the effects of Pydrin on non-target organisms. As a result of this pilot test and other previous tests, Pydrin is registered for both ground and aerial applications in southern pine seed orchards. This is a final report on efficacy data obtained at the Beauregard State Seed Orchard in 1980 and 1981.

METHODS

The insecticide treatments were applied at approximately monthly intervals as follows:

Application	1980	1981
1	May 6	May 7
2	May 28-29	June 9
3	June 30	July 8
4	August 4	August 4
5	September 8	September 9

A Bell Soloy Helicopter and an Ag Cat fixed wing were used to apply the insecticides in 1980 and 1981, respectively. The following application specifications were utilized for all applications:

Parameter	Helicopter (1980)	Fixed Wing (1981)
Nozzles	49 (D-02-28)	28 (D-06-46)
Boom pressure (PSIG)	40	40
Speed (MPH)	25	90
Swath width (ft.)	30	30
Release height above trees (ft.)	5	5
Number of passes	2	2
Adjuvant - Nalco-Trol®	5 oz/100 gal H_2O	3 oz/100 gal H_2O

Three 5 acre blocks were selected at the orchard in a loblolly pine seed source (figure 1). Treatment blocks were separated by 270 ft. buffer strips. One block was left untreated, one block was treated with Guthion at a rate of 2 lbs. of active ingredient per acre, and one block was treated with Pydrin at a rate of 0.67 lbs. of active ingredient per acre. Guthion 2S was applied in 1980 and Guthion 2F in 1981. The spray was applied by making 2 passes over each row. Half of the spray (5 gal/ac) was applied from one direction (north to south) and half from the other direction (south to north) for a total of 10 gals. of spray per acre.

In order to characterize droplet size and assess the spray coverage, Kromekote® spray cards mounted on corrugated cardboard holders were used. Prior to each application two rows of 25 cards were placed on the ground, within each spray block, perpendicular to the flight lines. A drift line of 10 spray cards was placed in the check block, parallel to the flight lines (figure 1).

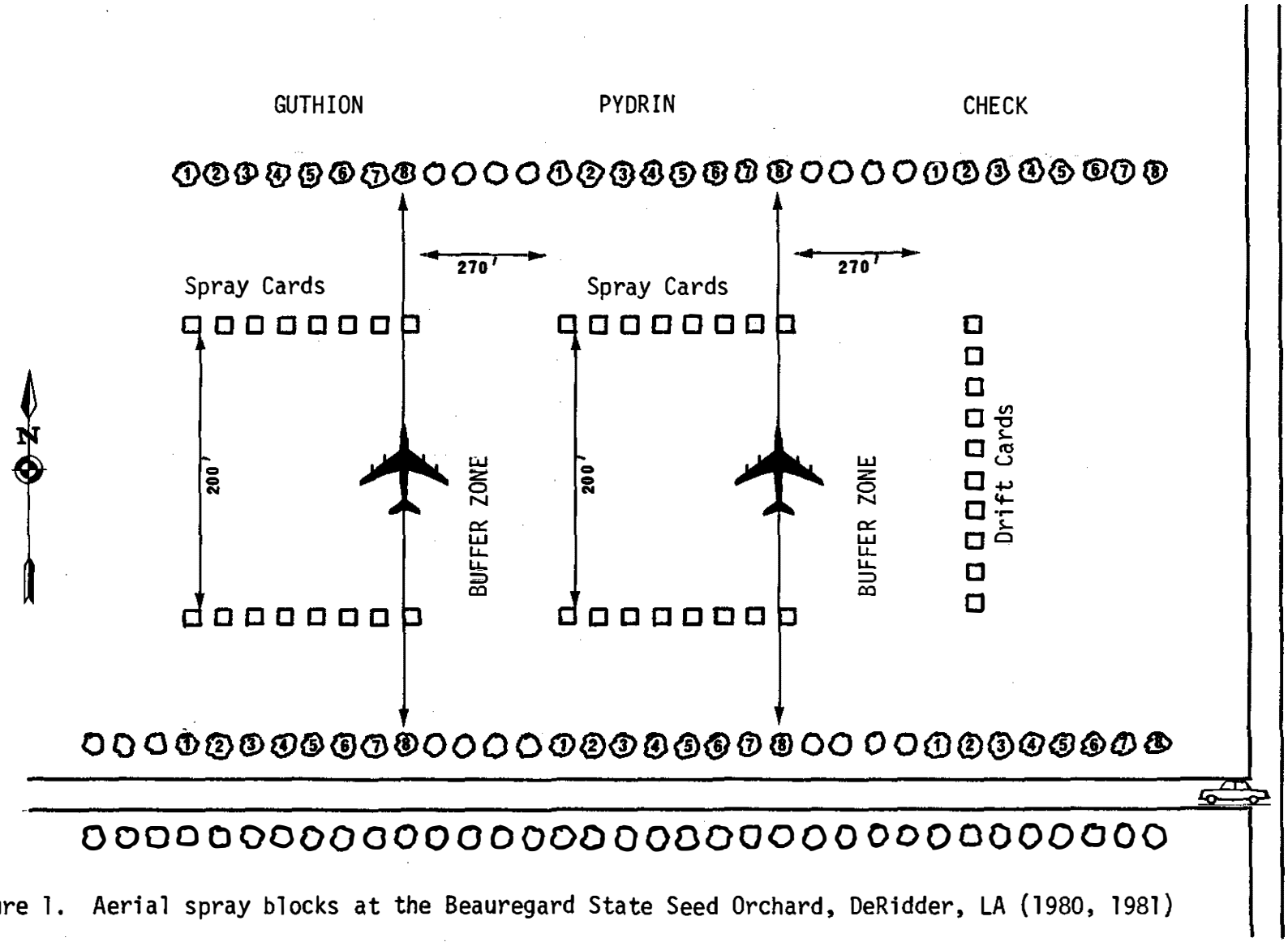

Figure 1. Aerial spray blocks at the Beauregard State Seed Orchard, DeRidder, LA (1980, 1981)

Prior to the first application, 3 trees were randomly selected in each spray block. Soft drink cans were wrapped with Kromekote spray cards and placed at the 4 cardinal directions in the top, middle and bottom portions of the crowns for a total of 12 cans in each tree.

After each application, the spray cards were mailed to the Methods Application Group, Davis, California, for analysis of droplet size by a quantimet analyzer. Data were analyzed for mass median diameter (MMD)[3/], drops/cm^2, and a calculation of gallons per acre was made from these analyses.

In order to evaluate the efficacy of each pesticide, 2 ramets of each of 6 clones in each treatment block were selected as sample trees. The criterion for selecting ramets was that each contain at least 26 second year cones. Six to 12 branches per ramet were flagged and the healthy conelets and cones on these branches were counted in March and September of 1980 and 1981. In addition, all cones from each sample ramet were collected and counted during September 1980 and 1981. Cones were categorized as coneworm dead, coneworm damaged, unknown dead, and unknown damaged.

Cone and seed analysis (Bramlett et al. 1977) was performed on 6 apparently healthy cones which were selected at random from the cones collected from each sample tree. The seed potential was determined by counting the total number of fertile scales per cone and multiplying by two. All seeds and second year aborted ovules were extracted and counted. The seeds were X-rayed and classified as healthy, seedbug damaged, seedworm damaged, malformed, and empty. The number of first year aborted ovules was determined by adding the number of extracted seeds to the number of second year aborted ovules and subtracting the total from the seed potential. The seed efficiency was calculated by dividing the number of sound seeds per cone by the seed potential. Each data set was analyzed by analysis of variance and Duncan's multiple range tests.

RESULTS

Conelet and Cone Damage

During both years Pydrin and Guthion applied via aircraft improved the survivorship of both conelets and cones compared to the survivorship in the check block (table 1). The full tree harvest of sample clones revealed that the cone survival (# of healthy cones/total # of cones) in the check, Guthion, and Pydrin blocks averaged 59%, 79%, and 80% in 1980 and 71%, 88%, and 88% in 1981, respectively. In both years Pydrin and Guthion significantly (P=.05) improved the cone survival compared to the cone survival of the check treatment (table 1). The percentages of the cone that died

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[3/] The droplet size diameter that divides the spray mass into equal parts

Table 1. Full tree harvest data, aerial spray pilot project, Beauregard State Seed Orchard (1980, 1981).

Treatment	Percentage[1/]			
	Healthy	Coneworm		Other
		Dead	Damaged	Damaged
Loblolly - 1980 Helicopter Application				
Check	59 A	29 A	9 A	2
Guthion® 2S - 2 lbs A.I./Ac.	79 B	14 B	4 B	2
Pydrin® 2.4 EC - 0.67 lbs. A.I./Ac.	80 B	14 B	4 B	1
Loblolly - 1981 Fixed Wing Application				
Check	71 A	22 A	6 A[2/]	0
Guthion® 2F - 2 lbs. A.I./Ac.	88 B	9 B	1 B	1
Pydrin® 2.4 EC - 0.67 lbs. A.I./Ac.	88 B	9 B	2 B	0

[1/] Any two means followed by the same letter are not significantly different at the 5 percent level by Duncan's multiple range test

[2/] Duncan's multiple range test run on arcsine square root transformation

due to coneworm feeding were reduced by more than half in the Guthion and Pydrin blocks (table 1). Full tree harvest data are conservative because cones killed early in the spring often fall from trees by harvest. If the sample size is large enough a more accurate measure of survivorship is obtained from the periodic sampling of tagged branches. Counts of conelets and cones made in the spring can be compared to counts in the fall. In this test, cone survival was followed from pollination to harvest for 2 years. Flower to cone survival averaged 67% and 66% in the Guthion and Pydrin blocks, respectively as compared with 30% for the check (table 2).

Seed Damage

Both Guthion and Pydrin treatments (1980, 1981) had fewer first and second year aborted ovules per cone than untreated checks (tables 3,4). In 1980 the numbers of sound seeds per cone for the Pydrin and Guthion treatments (78 in Pydrin block, 72 in Guthion block) were more than double the check (33 in check block) while in 1981 the numbers of sound seeds tripled in the insecticide treated areas (table 3,4). The seeds produced in 1981 had been protected for 2 years and therefore the 1981 seed efficiency (# of sound seeds/seed potential) was greater than the 1980 seed efficiency in the treated blocks. The seed efficiency in the check block was consistent during both 1980 and 1981. In 1980 and 1981 the percentages of empty seeds (often caused by seedbugs) were significantly ($P=.10$) less in the Pydrin and Guthion area as compared to the check area (table 3). In 1980 the identifiable seedbug damage (seed showing partial endosperm remaining) was low. In 1981 the percentage identifiable seedbug damage (15% in check block, 6% in Guthion block, and 6% in Pydrin block) decreased in the treated areas. Except for identifiable seedbug damage in 1980 no significant differences occurred between Pydrin or Guthion treatments for any of the sound seed or damaged seed categories.

Spray Assessment and Characterization

Droplet size (mass median diameter) obtained from the helicopter applications (1980) ranged from 350 um to 500 um in the Guthion trials and from 325 um to 439 um in the Pydrin trials (tables 5, 7). Drops deposited per cm^2 ranged from 27 to 38 in the Guthion trials and from 18 to 37 in the Pydrin trials. Gallons per acre penetrating the orchard canopy and reaching the ground spray cards ranged from 2.35 gal to 6.67 gal in the Guthion trials and 1.96 gal to 3.66 gal in the Pydrin trials.

Droplet size obtained from the fixed wing applications (1981) ranged from 420 um to 670 um in the Guthion trials and from 327 um to 378 um in the Pydrin trials (tables 6, 8). Drops deposited per cm^2 ranged from 40 to 72 in the Guthion trials and from 38 to 94 in the Pydrin trials. Gallons per acre penetrating the orchard canopy and reaching the ground spray cards ranged from 1.86 gal to 7.77 gal in the Guthion trials and from 3.21 gal to 6.95 gal in the Pydrin trials.

The average mass median diameter reaching the orchard floor was larger with fixed wing application (361 um in Pydrin area, 554 um in Guthion area) than with helicopter application (360 um in Pydrin area, 426 um in Guthion area). In addition, the number of drops per cm^2 doubled in the fixed wing applications

Table 2. Cone and conelet survival percentages, aerial spray pilot project, Beauregard State Seed Orchard (1980, 1981).

Treatment	Conelets[1/]			Cone[1/]			Flower-Cone[1/]	
	1980	1981	Comb.	1980	1981	Comb.	1980	1981
Check	54 A	55 A	56	57 A	48 A	53	30 A	
Guthion - 2 lbs. A.I./Ac.	83 B	86 B	84	77 B	82 B	80	67 B	
Pydrin - 0.67 lbs. A.I./Ac.	77 B	90 B	81	80 B	84 B	82	66 B	

[1/] Any two means followed by the same letter are not significantly different at the 5 percent level by Duncan's multiple range test

Table 3. Seed data, aerial spray pilot project, Beauregard State Seed Orchard (1980).

Treatment	Number/Cone			Percentage of Seed Potential		
	1st Year Aborted Ovules	2nd Year Aborted Ovules	Sound Seed	Seed Efficiency	Empty Seed	Ident. Seedbug
Check	87 A[1/]	10 A[2/]	33 A[2/]	22 A[2/]	13 A[3/]	1
Guthion	65 B	1 B	72 B	48 B	7 B	0
Pydrin	56 B	1 B	78 B	52 B	5 B	3

1/ Treatment means not followed by the same letter are significantly different at the 5% level of significance by Duncan's multiple range test.

2/ Treatment means not followed by the same letter are significantly different at the 1% level of significance by Duncan's multiple range test.

3/ Treatment means not followed by the same letter are significantly different at the 10% level of significance by Duncan's multiple range test.

Table 4. Seed data, aerial spray pilot project, Beauregard State Seed Orchard (1981)

Treatment	Number/Cone			Percentage of Seed Potential		
	1st Year Aborted Ovules	2nd Year Aborted Ovules	Sound Seed	Seed Efficiency	Empty Seed	Ident. Seedbug
Check	41	20	24	20 A[1/]	14 A[2/]	15 A[1/]
Guthion	20	10	77	64 B	5 B	6 B
Pydrin	22	12	72	60 B	5 B	6 B

[1/] Treatment means not followed by the same letter are significantly different at the 1% level of significance by Duncan's multiple range test.

[2/] Treatment means not followed by the same letter are significantly different at the 10% level of significance by Duncan's multiple range test.

Table 5. Guthion spray deposit data (ground lines) applied to Beauregard Seed Orchard by Bell 47 Soloy at 10 gal/ac, 1980.

TRIAL	DATE	MMD(um)[1/]	DROPS/cm^2	GAL/AC
1	May 6	500	32	6.67
2	May 28	415	36	4.28
3	June 30	455	27	3.86
4	Aug. 4	350	31	2.35
5	Sept. 8	410	38	4.66
MEAN		426	33	4.36

[1/] Mass median diameter

Table 6. Guthion spray deposit data (ground lines) applied to Beauregard Seed Orchard by Ag Cat at 10 gal/ac, 1981.

TRIAL	DATE	MMD(um)[1/]	DROPS/cm^2	GAL/AC
1	May 7	537	54	4.36
2	June 9	586	40	6.09
3	July 8	670	45	7.77
4	Aug. 4	420	72	4.50
5	Sept. 9	557	44	1.86
MEAN		554	51	4.92

[1/] Mass median diameter

Table 7. Pydrin spray deposit data (ground lines) applied to Beauregard Seed Orchard by Bell 47 Soloy at 10 gal/ac, 1980.

TRIAL	DATE	MMD(um)[1/]	DROPS/cm^2	GAL/AC
1	May 6	439	18	3.66
2	May 29	328	29	2.84
3	June 30	325	19	1.96
4	Aug. 4	358	24	2.90
5	Sept. 8	348	37	3.64
MEAN		360	25	3.00

[1/] Mass median diameter

Table 8. Pydrin spray deposit data (ground lines) applied to Beauregard Seed Orchard by Ag Cat at 10 gal/ac, 1981.

TRIAL	DATE	MMD(um)[1/]	DROPS/cm^2	GAL/AC
1	May 7	361	63	4.73
2	June 9	370	38	4.16
3	July 8	378	54	5.79
4	Aug. 4	327	94	6.95
5	Sept. 9	369	60	3.21
MEAN		361	62	4.97

[1/] Mass median diameter

as compared to the helicopter applications. These differences resulted in larger deposits on the orchard floor with fixed wing application. Approximately 5 gallons of spray per acre were recovered in the fixed wing treatment and 3.5 gallons per acre were recovered in the helicopter treatment.

For the first trial in 1980, cards were placed in trees. In the Guthion plot, the average mass median diameter (MMD) was 465 um, the mean deposit was 23 droplets per cm^2, and the mean deposit in gallons per acre was 3.38 (table 9). In the Pydrin plot, the average mass median diameter of droplets was 406 um, the average deposit was 9 droplets per cm^2, and the average deposit in gallons per acre was 1.33 (table 10). Similar assessments were attempted in 1981 but the spray cards were too dirty to analyze accurately. Based upon the increased deposits on the orchard floor in 1981 it is likely that the 1981 tree deposit data would average less than that obtained in 1980.

No spray deposits were registered on drift cards in the check block.

DISCUSSION

Pydrin (0.67# AI/AC) and Guthion (2.0# AI/AC) were equal in effectiveness when comparisons were made within years. Too many variables were changed in 1981 to allow comparisons between years. In order to effectively summarize and compare the production data for each treatment, life table procedures were utilized. Table 11 summarizes these data. If 1,000 flowers existed in each treatment area during the spring of 1980, by the fall of 1981 only 302 cones, 605 cones, and 672 cones would remain on the trees in the check, Pydrin, and Guthion blocks, respectively. Assuming that the mean seed potential per cone equaled 120, these cones at harvest (1981), could produce 36,240 seeds in the check block, 72,600 seeds in the Pydrin block and 80,640 seeds in the Guthion block. Because the seed efficiency is never equal to 100%, additional mortality is subtracted from the seed potential of surviving cones. Seed efficiency equaled 20%, 60%, and 64% in the check, Pydrin, and Guthion areas in 1981. After reducing the seed potential by the seed efficiency approximately 7,248 full seeds would be produced in the check block, 43,560 full seeds in the Pydrin, and 51,610 full seeds in the Guthion block. Based upon the survivorship values obtained in this pilot test approximately 6% of the total seed potential of these 1,000 flowers would have survived until extraction in untreated areas. Approximately 36% would have survived in Pydrin areas, and approximately 43% would have survived in Guthion areas.

While the 2 methods of application, fixed wing and helicopter, were not compared during any one year, the trends in the efficacy data between years indicate that both fixed wing and helicopter applications can effectively reduce losses over untreated areas.

SUGGESTIONS FOR FUTURE PROJECTS

Now that aerial application of Pydrin and Guthion has become a registered and accepted method of application Forest Pest Management needs to re-evaluate the aerial application recommendations. Future special projects should be

Table 9. Summary trial 1, Guthion spray deposit data (trees) applied to Beauregard Seed Orchard by Bell Soloy at 10 gal/ac.

INSECTICIDE	SAMPLING AREA	MMD(um)[1/]	DROPS/cm^2	GAL/AC
Guthion	Top	476	24	3.77
	Middle	428	26	3.26
	Bottom	455	20	3.10
TREE MEAN		465	23	3.38

[1/] Mass median diameter

Table 10. Summary trial 1, Pydrin spray deposit data (trees) applied to Beauregard Seed Orchard by Bell Soloy at 10 gal/ac.

INSECTICIDE	SAMPLING AREA	MMD(um)[1/]	DROPS/cm^2	GAL/AC
Pydrin	Top	359	5	0.59
	Middle	412	11	1.81
	Bottom	392	11	1.60
TREE MEAN		406	9	1 33

[1/] Mass median diameter

Table 11. Life table comparisons of seed production from the 1981 cone crop in check, Pydrin, and Guthion blocks at the Beauregard State Seed Orchard (1980, 1981).

	CHECK			PYDRIN®			GUTHION®		
Stage	# Per Stage	Percent Lost	Number Lost	# Per Stage	Percent Lost	Number Lost	# Per Stage	Percent Lost	Numb Lost
Flowers	1,000			1,000			1,000		
		43	430		28	280		18	18
1st Year Cones	570			720			820		
		47	268		16	115		18	14
2nd Year Cones	302			605			672		
Seed Potential[1/]	36,240			72,600			80,640		
		80	28,992		40	29,040		36	29,03
Full Seed	7,248			43,560			51,610		
Total % of Seed Potential, Based on 1,000 Flowers[2/]		6			36			43	

[1/] Seed potential in 1981 = 120 seeds per cone X the number of healthy cones

[2/] Total % of seed potential, based on 1,000 flowers = full seeds produced ÷ (120 seeds per cone X 1,000 flowers)

designed in cooperation with Research and Pesticide Application Specialists to:

1) Determine whether 2 passes from opposite direction provides better control than 1 pass;

2) Determine the lowest effective rate for both Guthion and Pydrin; and

3) Determine the role of aerial application in the buildup of sucking insect populations.

REFERENCES

Bramlett, D.L. et al. 1977. Cone analysis of southern pines, A Guide Book, General Technical Report SE-13 p. USDA, Forest Service, Southeastern Forest Experiment Station, Asheville, NC, and Southeastern Area, S&PF, Atlanta, GA.

Overgaard, N.A. 1981. Progress Report - Pilot test for controlling coneworms and seedbugs by aerial application of Pydrin® and Guthion® at the Beauregard Seed Orchard, Louisiana. USDA, Forest Service, Southeastern Area, S&PF, Report No. 81-2-16, 15 pp.

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in their original containers under lock and key out of reach of children and animals, and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear appropriate protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure it is still registered for the intended use. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).

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Prepared by: Julie C. Wheatley
Entomologist

Neil O. Overgaard
Entomologist

Reviewed by: J. L. Olivera
Supervisory Entomologist

Approved by: J. L. Olivera
for HARVEY V. TOKO
Staff Director
Forest Pest Management

SOUTHERN REGION, STATE AND PRIVATE FORESTRY
USDA, FOREST SERVICE, ATLANTA, GA 39367